

Quarterly Progress Report
For
Mercury Removal in a Non-Thermal, Plasma-Based
Multi-Pollutant Control Technology for Utility Boilers

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This quarterly report describes progress Powerspan Corp. has made in the last three months on specific tasks listed in the Cooperative Agreement. We are currently working on and charging costs to the following tasks:

Task 1: Install and Test Hg Monitoring Equipment

Task 2: Baseline Measurements

Task 6: Determine Processes to Remove Mercury from Liquid Effluent Streams

Task 7: Technology Transfer

Reports on the status for each of these tasks are presented below.

Task 1: Install and Test Hg Monitoring Equipment

We have essentially completed all required items under this task. The exception to this however is completion of a technical report detailing the final configuration of the Hg measuring system and the system operating protocols. We expect to deliver this technical report to DOE by the end of November 2002.

Task 2: Baseline information

The goal of Task 2 is to fully characterize the incoming flue gas, including the quantity and speciation of mercury and the removal that takes place in the pilot's two dry ESP fields. Through this, we will gain an understanding of the fate of mercury in the system when no ECOTM Technology components are operating. During this task we are hoping to characterize the variation in mercury levels and speciation that may be expected during parametric and extended operation tests. Instrumentation and sample extraction and analysis is done using the equipment and the procedures developed in Task 1.

In the "Statement of Work" in the cooperative agreement we stated that we would obtain seven days of mercury speciation data across the dry fields. To date we have three days of reliable data. While the sample probes across the precipitator have been operated much longer than this we have reason to believe that some of the data is not accurate. We plan on having 5 additional days of continuous Hg speciation data across the

precipitator in the first week of November. A complete set of this data including calibration data, blanks, elemental mercury loading and total mercury loading measurements will be supplied to DOE.

We have made a tremendous amount of progress towards using our mercury measurement system as a Continuous Emission Monitoring system (CEMs). We have been able to solve many of the sampling and instrumentation issues that have come up in the course of our testing. We are now able to run inlet and outlet Hg instrumentation for several days at a time, with only minor need for operator involvement. Daily data is now routinely collected, downloaded and analyzed. One issue remains however, and that is the problem of ash collecting on the system inlet sample probe filters. The ash collects in a layer around the outside of the filter and cannot be effectively removed by the probe “blowback” feature. We think that elemental mercury is oxidized as it passes through the ash layer, thereby skewing the elemental / oxidized Hg ratio. Evidence and data for this effect was presented in the last quarterly report (June 2002). Additionally, when the filters are pulled from the housing for cleaning, trace amounts of ash contaminate sample lines and impingers in the conditioning systems, thereby artificially raising the measured levels of total mercury in the flue gas. Evidence for this contamination is presented below. We are currently working with PS Analytical and Baldwin Environmental to solve this problem. In the interim, we are also investigating use of an inertial separation sample probe to deliver particle free flue gas to the mercury instrument conditioners.

For several days this quarter, one of our Hg instruments was “stream switched” between two sample probes / conditioners. One sample probe is located before the dry electrostatic precipitators and the other is located after the precipitators. We ran the instrument in this mode for several days while our Hg addition system was operating. Preliminary data for part of this time period is shown in figures 1 and 2 below. Figure 1 shows the behavior of Total Hg across the dry fields while Figure 2 show the amounts of elemental Hg measured across the dry fields for the same time period.

In figure 1, large “spikes” in the Total Hg measurements due to ash contamination are quite obvious. To combat this contamination, the Teflon filters are routinely removed and cleaned. Additionally, the heated sample lines and the sample conditioners are rinsed with a 10% nitric acid solution then rinsed with DI water. After this maintenance is

performed the brief elevated measurements of Total Hg are eliminated. Large variations of elemental Hg however are not apparent, indicating the ash contamination does not affect this measurement as much as total Hg measurement.

When the large values of Total mercury are removed from the data (using a gradient filter), it would appear that the “baseline” measurements of Total Hg after the dry field seem somewhat larger than baseline measurement of Hg Total before the dry fields.

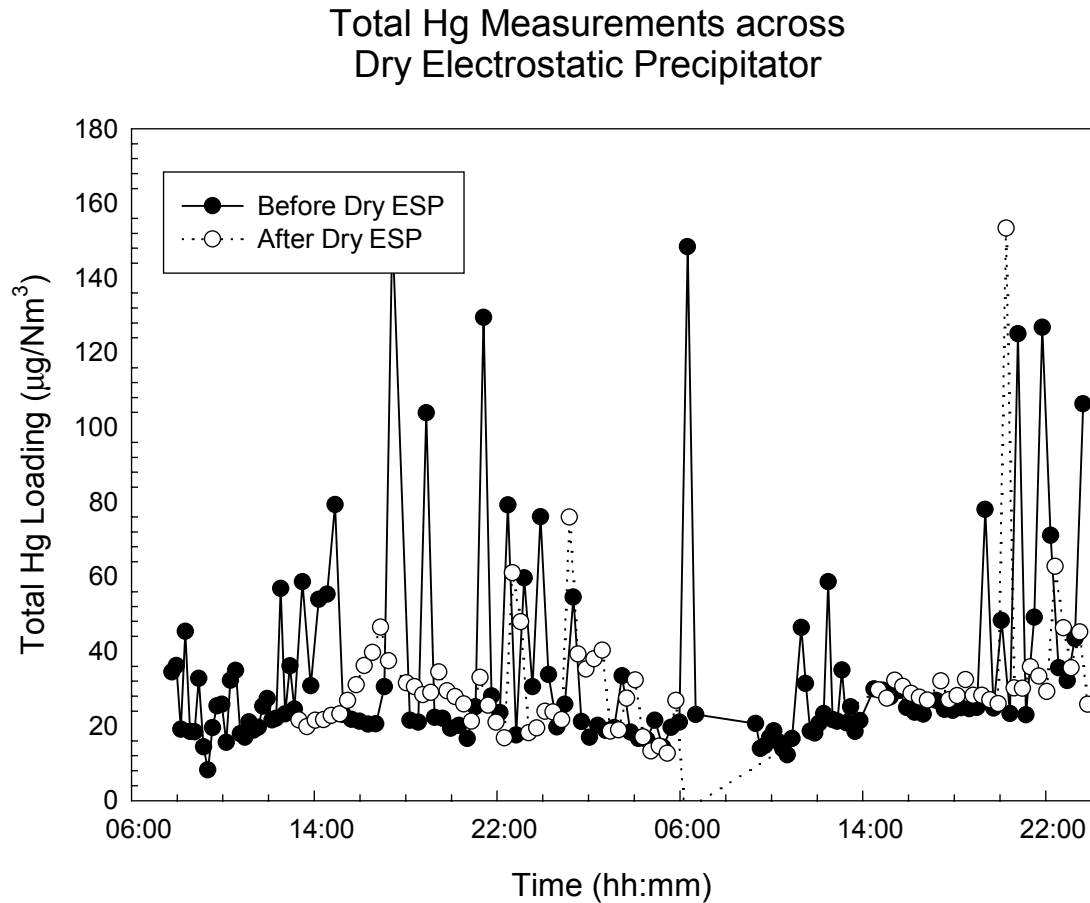


Figure 1

The apparent increase in gas phase mercury measured across the dry ESP fields may be due to capture of gas phase mercury on inlet filter, which develops a thicker ash layer due to the higher ash loading at this location.

Figure 2 below, shows the elemental mercury measurements across the dry electrostatic precipitator for the same time interval as that presented in figure 1. The data shows that there is little change in the measured elemental mercury concentration as the flue gas passes through the dry ESP fields.

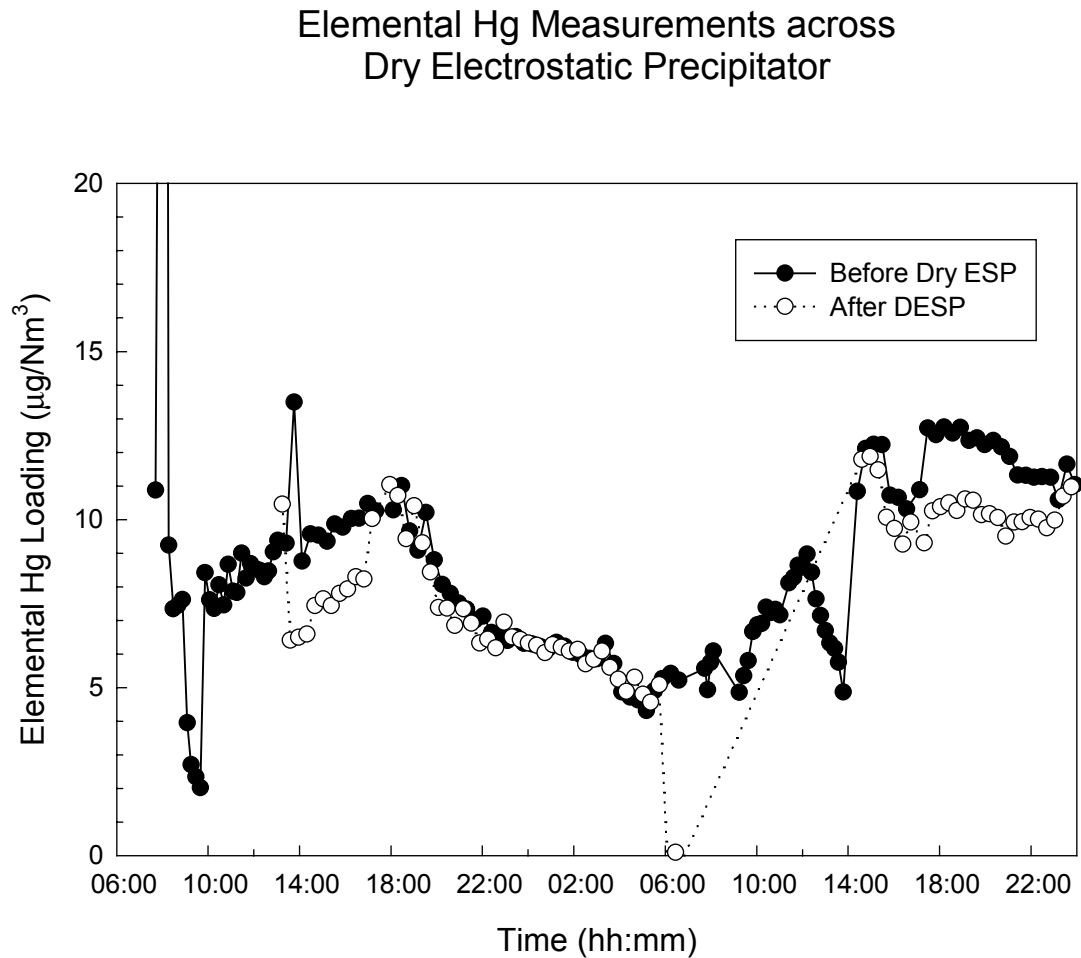


Figure 2

This measurement also proves to be somewhat of a reality check on our instrumentation. We have used a single instrument to measure mercury speciation in two different locations in our process and obtained reasonable results. We have also taken gas streams from a single probe and sample conditioner and run the stream on two

different PS Analytical analyzers. The results of the single gas stream measured on separate analyzers proved the analyzers to be in good agreement.

Task 6: Determine Processes to Remove Mercury from Liquid Effluent Streams

The ECO Process removes Hg from a flue gas stream by absorbing it into a process fluid that is used to produce a valuable ammonium sulfate nitrate fertilizer. To maintain the value of the fertilizer produced, it is important to understand where the mercury reports in the process and to remove it from the liquid effluent if necessary. Development efforts focused on the following areas: (i) measurement of mercury in liquid solutions representative of ECO process fluid, (ii) verification that activated carbon removes Hg from ECO process fluid, and (iii) parametric testing of mercury removal with activated carbon.

Initial testing of the mercury analysis by EPA Method 245.2 in ECO process fluid showed components that interfered with the measurements. Due to these interferences, the method was modified to use a nitric acid digestion rather than a digestion with sulfuric acid, nitric acid, potassium permanganate, and potassium persulfate. After digestion, the Hg measurement is done with CVAAS after reducing the Hg with stannous chloride similar to method 245.2.

The type of activated carbon being used for mercury removal is Mersorb[®] LW, manufactured by Nucon International. It is a sulfur impregnated activated carbon used commercially to adsorb mercury from wastewater streams. Since ECO process fluid is not similar to wastewater streams, testing of the Mersorb with representative solutions was performed to verify its ability to remove Hg under representative conditions. Pre- and post- filtration along with a guard column is used in conjunction with the Mersorb for Hg removal. The filtration steps are to remove ash prior to the column and to keep any fragments that come from the column from re-entraining mercury into the liquid. The guard column, Nusorb[®], is also activated carbon, but is not impregnated with sulfur. The guard column is used to remove any organic components from the process fluid that would decrease the life of the Mersorb column. The Nusorb also has an affinity for mercury and can remove up to 50% of the mercury. A filtration system consisting of pre-filtration, Nusorb guard column, Mersorb LW column, and post-filtration was used to

treat effluent from the Burger pilot. The treatment of the effluent resulted in a decrease in Hg concentration from 197 ppb to <20 ppb. The ability of Mersorb to remove Hg from ECO process solutions was verified.

Focus turned to parametric testing in the following areas: (i) pH affects (ii) solution composition effects, and (iii) Hg capacity of the Mersorb system. Table 1 reports the results of the ability of Mersorb to remove Hg as a function of pH. The results show in the pH range from 4 to 7 that the Mersorb system is effective at decreasing the Hg concentration to <20 ppb.

pH	Before Mersorb Treatment [Hg] / (ppb)	After Mersorb Treatment [Hg] / ppb
7	122	BDL
6	454	17
5	276	10
4	431	12

Table 1

Parametric testing of the ability of Mersorb to perform as a function of ammonium thiosulfate, sulfite, and hydrogen peroxide concentration is currently under way.

Verification and testing of the capacity of the Mersorb system as a function of pH is also being tested. A small bench scale system has been constructed to verify the manufacturers capacity claims. Verification will be done over a pH range of 4-7.

Task 7: Technology Transfer

Task 7, as stipulated in the Cooperative Agreement, is meant to provide for the transfer of information about the ECO™ process to the air pollution control community and to the public in general. On Sept. 12, 2002, Dr. Christopher McLarnon, Powerspan's Director of Research & Development, presented a paper entitled, "Mercury Removal in a Multi-Pollutant Control Technology for Utility Boilers" at the Air Quality III Conference in Arlington, VA. This conference focused on mercury, trace elements and particulate matter, and provided an opportunity for government and industry experts to discuss topics related to the regulation, transport, measurement, and control of air emissions.

Powerspan's CEO, Frank Alix, was a presenter in a workshop at the Coal-Gen conference on Wednesday, July 31. The workshop, "Better Multi-Pollutant Control Strategies," addressed ways to optimize removal of sulfur dioxide, nitrogen oxide, mercury, and air toxics produced during coal combustion. The four-hour workshop featured presentations by industry experts followed by interactive debate. Coal-Gen was held in St. Louis from July 31 to August 2, 2002, at the America's Center.

Powerspan's President and COO, Phil Boyle, testified before the Ohio House Energy Policy Committee on August 13, 2002. The hearing consisted of two panels of eleven government and industry speakers who discussed the development and commercialization of clean-coal technology and the uses of coal byproducts. Phil spoke about the history of ECO™ (Electro-Catalytic Oxidation) technology and the cooperation of various stakeholders in its development.

Financial Information Update

A brief table outlining the budget and expenditures to date is provided below.

Category	Expended Amounts (to date)	Budgeted Amounts (to date)
Personnel	\$ 400,287	\$ 572,140
Travel	\$ 85,975	\$ 63,290
Equipment	\$ 240,266	\$ 257,540
Supplies	\$ 199,061	\$ 81,000
Contracts	\$ 36,526	\$ 119,820
Indirect Charges	\$ 66,714	\$ 88,682
Total Costs	\$ 1,028,828	\$ 1,182,472

Table 1: Budget summary as of 18 October 2002.

Schedule

Task 1: 95 % Complete. We expect to complete this task by the end of November 2002. The only item outstanding, with respect to the statement of work, is the completion of the Technical report. This report will identify the final configuration of the mercury measurement system, the operating protocols as well as documentation verifying the adequacy of the operating protocols.

Task 2: 60% Complete. Presently we have 3 days of data identifying mercury speciation across our dry electrostatic precipitator. We are currently in the process of obtaining the remainder of the required data. We expect to have obtained the remainder of the data by the end of the week (November 8, 2002).

Task 3: 0% Complete. We expect to start this task during the week of November 11, 2002. The purpose of this task is to determine the effect of the dielectric barrier discharge on mercury speciation. The sample probe and sample conditioner needed for this task are in place and ready to be operated.

Task 4: 0% (Not yet started)

Task 5: 0% (Not yet started)

Task 6: 50 % complete. Testing continues at the pilot and in the laboratory. Pilot testing is focused on Hg removal from the liquid product stream. Laboratory testing on the capacity of Mersorb and Nusorb sorbents for Hg capture at liquid conditions representative of ECO liquids is ongoing.

Task 7: 50 % complete. This technology transfer task is continuing and will most likely be ongoing throughout the course of the project.

Task 8: not yet started

Acknowledgments:

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